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United States Patent

[19]

Moustakas[11] **Patent Number:** **5,686,738**[45] **Date of Patent:** **Nov. 11, 1997****[54] HIGHLY INSULATING MONOCRYSTALLINE GALLIUM NITRIDE THIN FILMS****[75] Inventor:** **Theodore D. Moustakas**, Dover, Mass.**[73] Assignee:** **Trustees of Boston University**, Boston, Mass.**[21] Appl. No.:** **372,113****[22] Filed:** **Jan. 13, 1995****Related U.S. Application Data****[63]** Continuation of Ser. No. 113,964, Aug. 30, 1993, Pat. No. 5,385,862, which is a continuation of Ser. No. 670,692, Mar. 18, 1991, abandoned.**[51] Int. Cl.⁶** **H01L 33/00; H01L 29/20****[52] U.S. Cl.** **257/103; 257/94; 257/79; 257/615****[58] Field of Search** **257/103, 94, 79, 257/615****[56] References Cited****U.S. PATENT DOCUMENTS**

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This invention relates to a method of preparing highly insulating GaN single crystal films in a molecular beam epitaxial growth chamber. A single crystal substrate is provided with the appropriate lattice match for the desired crystal structure of GaN. A molecular beam source of Ga and source of activated atomic and ionic nitrogen are provided within the growth chamber. The desired film is deposited by exposing the substrate to Ga and nitrogen sources in a two step growth process using a low temperature nucleation step and a high temperature growth step. The low temperature process is carried out at 100-400° C. and the high temperature process is carried out at 600-900° C. The preferred source of activated nitrogen is an electron cyclotron resonance microwave plasma.

21 Claims, 4 Drawing Sheets